

Enhancing milk production of lactating camels in Kenya via supplementation of the invasive Cactus (*Opuntia stricta*) in the diet

W.O. Owino^{1*}, L.W. Ikanya², J.G. Maina², C.K. Gachui², and J.C.B. Dubeux Jr.³

¹College of Agriculture and Natural resources, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200 Nairobi, Kenya

²Department of Animal Production, College of Agriculture and Veterinary Sciences, University of Nairobi, P.O Box 29053-00625, Kangemi, Kenya

³University of Florida, North Florida Research and Education Center, Marianna, FL, USA.

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Abstract.

Climate change leading to prolonged and recurrent droughts, changes in land use, primarily settlement of pastoralists, followed by overgrazing and subsequent land degradation, has made the highly drought resistant *Opuntia* flourish and be aggressively invasive in the Kenya's rangelands. Camel keeping has increasingly replaced cattle as a climate adaptation strategy and also as a result of a steady increase in demand for camel milk due to the associated nutritional and health benefits. To address the challenge of lack of pasture during prolonged drought, there is the need to utilize the invasive cactus as fodder. The invasive cactus can be a kind of 'Drought-Insurance' in these regions due to its ability to retain its nutrition and productivity in water deficit conditions. This study reports on the incorporation of the invasive cactus together with a protein source in increasing the milk yield of lactating camels in one of the semi-arid land regions of Kenya.

Introduction

Cactus (*Opuntia stricta*) was introduced in Kenya the 1890s by the railway construction workers as a protective fence to shield them from wild animals which were roaming the land (Pholhil and Redhead, 1968). Since the cactus is not native to Kenya and therefore had no natural predators, with time it invaded the grazing rangelands that were typically used by pastoralists (Strum et al, 2015). Climate change issues such as prolonged droughts, changes in land use primarily settlement of pastoralists, followed by overgrazing and subsequent land degradation, made the highly drought resistant cactus flourish and become aggressively invasive and currently covers hundreds of acres of land in the rangelands.

During drought the domestic and wild animals in the rangelands have nothing else to feed on other than cactus due to absence of other forage species. The animals are fond of either the cladodes or cactus pear fruit (when accessible), particularly when new flowers appear. Consumption of cactus fruit by domestic herd aids the dispersal of the seeds and further dispersal is aided by birds and animals, such as elephants and baboons, who eat the fruit and disperse the seeds leading to its out-of-control invasion of the rangelands (Shackleton et al., 2017). In the last decade, government and non-governmental organizations and locals have been waging a war to control the runaway invasive cactus by chopping using machetes, manual uprooting and burying, use of herbicides, burning or biological control using the cochineal insects but with limited success (Witt et al., 2020).

Climate change has aggravated the impact of current and recent droughts in the Arid and Semi-Arid Lands (ASALs) of East Africa. Prolonged drought constrain access to water and pasture for livestock leading to increased incidences of certain livestock diseases and livestock deaths. Camel keeping has increasingly replaced cattle as an adaptation to droughts and varying pasture quality in ASALs (Kangunyu and Wanjohi, 2015). Camels are able to survive well in ASALs due to their biological and physiological adaptations which help them to cope with harsh environmental conditions. Furthermore, there has been a gradual increase in demand for camel milk due to the associated nutritional and health

benefits. Camels are naturally browsers on trees and shrubs during the wet season but are less indiscriminative during the dry season because of forage scarcity. Studies have shown that the utilization of prickly pear in ruminant diets can only replace the conventional feeds partially. The *Opuntia* is processed by completely crushing the spines in the cladodes or pads to produce a thick pulp that is fed to animals or removal of spines through bonfires (Kang'ara and Gitari, 2008). However, *Opuntia* cladodes lack sufficient crude protein and protein supplementation is necessary (Mashope, 2007). Therefore, this study combined *Opuntia* with cotton seed cake as diet for lactating camels and determined its effect on feed intake, milk yield and milk composition.

Methods and Study Site

The study was carried out in Doldol area in Laikipia County which is an ASAL and has been extensively been invaded by *Opuntia*. Being an ASAL it has a large population of camels. Eight Somali lactating camels were selected randomly from different herds through visual assessment for healthy camels. The experiment was set in a Latin Square Design with four treatments (diets), two blocks, four camels each block for 84 days. The four dietary treatments were assigned randomly to camels in each block. Each diet treatment was fed for a period of 21 days for each camel and samples were collected from 14th day of feeding. The camels were fed on the supplementary diets' *ad libitum*. The camels were allowed to graze on rangeland for a about 9 hours and then supplemented with experimental cactus pad diets for 4 h at night prior to milking. The cactus pads were harvested and chopped daily to allow for 3kg DM of cactus per camel per day. For the treatment that consisted of cactus and cotton seed cake, cactus and cotton seed cake were mixed before feeding. Common salt was added to the experimental diets and offered *ad libitum* to the camels on control treatments throughout the experimental period

The supplemental diets used in the study are as indicated and were offered in separate tough compartments.

Table 1. Different diet supplementation treatment for camels with *Opuntia stricta* for a period of 84 days

Treatment	Feeding regime
1	Grazing in the rangeland (Only)(Control)
2	Grazing + supplementation with cactus <i>Opuntia stricta</i> (3 kg DM)
3	Grazing + supplementation with cactus (3 kg DM) and cotton seed cake (3 kg)
4	Grazing + supplementation with cotton seed cake (3 kg)

Milk production, composition and sensory evaluation was then determined.

Results and Discussion

Each treatment was significantly different ($P<0.05$) in terms of Feed intake and milk yield. Milk yield increased significantly with increase in feed intake. The dry matter intake of *O. stricta* was greater ($P<0.001$) in camels fed on milled cactus treated with urea (4.14 kg DM) than untreated milled *O. stricta* (3.78 kg DM).

Table 2. Feed intake, milk yield, and milk composition of lactating camels on different supplementation diets

Parameters	Treatment + SEM			P-Value
	Grazing	Grazing+ chopped cactus	Grazing+ milled cactus + urea	

Milk volume (Liters)	3.37±0.1 ^a	4.69±0.29 ^b	5.03±0.43 ^b	6.03±0.13 ^c	<.001
Consumption of supplement, kg of DM	0±0	2.43±0.39 ^a	3.78±0.12 ^b	4.14±0.21 ^c	<.001

Camels fed on cactus milled with a forage crushing machine recorded higher dry matter intake (3.78 kg DM) than the manually chopped cactus (2.43 kg DM). This indicates that milling cactus with a forage machine influenced dry matter intake by the camels. The control camels had a milk yield of 3.37 L while those supplemented with chopped cactus produced 4.69 L 5.03 L in camels supplemented with milled cactus and 6.03 L in camels supplemented with milled cactus treated with urea.

Table 2. The Sensory attributes of milk against various treatments

Treatment	Attribute					Overall acceptability
	Appearance	Flavor	Mouthfeel	Preference	Smell	
O. stricta	6.983±0.30	5.357±0.55	5.164±0.31	1.367±0.09 ^b	5.46±0.28	5.185±0.36 ^a
O. stricta+CSC	6.929±0.18	5.418±0.52	4.989±0.34	1.386±0.11 ^b	5.285±0.45	5.689±0.49 ^{ab}
Grazing only	6.472±0.08	4.917±0.38	5.077±0.27	1.395±0.11 ^b	5.106±0.41	5.189±0.44 ^a
CSC	7.098±0.31	5.309±0.55	5.085±0.36	1.347±0.11 ^b	5.388±0.32	5.576±0.34 ^a
Cow	6.699±1.24	5.833±0.83	6.086±0.51	1.285±0.25 ^{ab}	5.674±0.96	5.91±0.62 ^{ab}
Goat	6.808±0.56	6.414±0.01	6.385±0.15	1.088±0.06 ^a	6.024±0.19	6.746±0.15 ^b

^{ab} means within a column are significantly different (P≤0.05)

Hedonic scale; 9- Like extremely; 8- Like very much; 7- Like moderately; 6- Like; 5- Neither like nor dislike; 4- Dislike; 3- Dislike moderately; 2- Dislike very much; 1- Dislike extremely. Preference was either yes as 1 or no as 2.

There was no significant difference (p>0.005) between cow milk, goat milk, and camel milk of camels fed *O. stricta* and CSC in overall acceptability. This revealed that camel milk of camels fed *O. stricta* and CSC was acceptable by the consumers. The low overall acceptability of camel milk observed in the present study concurs with earlier reports on camel milk (Mohamed, 2011).

Conclusions

It is possible to supplement grazing lactating dairy camels with milled *Opuntia stricta* treated with urea to increase milk yield and dietary supplements did not significantly affect the sensory characteristics of camel milk

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